Overview of IHRA Compatibility Test Development

Stephen Summers

NHTSA

IHRA Vehicle Compatibility

Improve occupant protection by developing internationally agreed upon test procedures designed to improve the compatibility of car structures in front-to-front and front-to-side impacts

IHRA Vehicle Compatibility

Enhanced prospects for improved frontal evaluation procedures.

Agreed upon relevant aspects include:

- Good structural interaction

- Maintaining occupant compartment integrity

- Predictable structural performance

- Controlling deceleration time histories

IHRA Vehicle Compatibility

Candidate Test Procedures Include:

- Full Frontal Barrier Test With Load Cells
  - Rigid Wall with or without a Deformable Element
- Offset Deformable Barrier (ODB) with Load Cells
- Passenger Compartment Integrity Test Using ODB
- Progressive Deformable Barrier (PDB)
- Moving Deformable Barrier
  - Using load cell criteria or PDB

Full Barrier Testing

Several Barrier designs are being evaluated

- With and without deformable faces

Evaluation Criteria are being developed for vehicle geometry and stiffness

- Average Height of Force
- Coefficient of Variation
- Linear Stiffness, Peak Power, others...

Average Height of Force

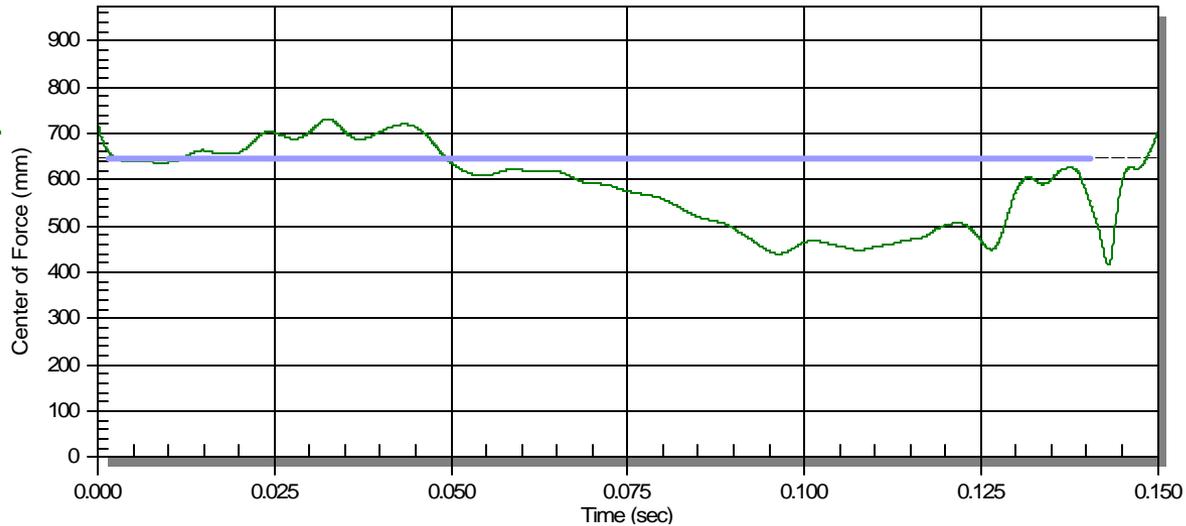**Compute the effective height of the applied force on the barrier face**

$$F_i \quad = \quad F$$

$$H_i$$

Average Height = $\dfrac{\displaystyle\sum_{1}^{N} F_i H_i}{\displaystyle\sum_{1}^{N} F_i}$
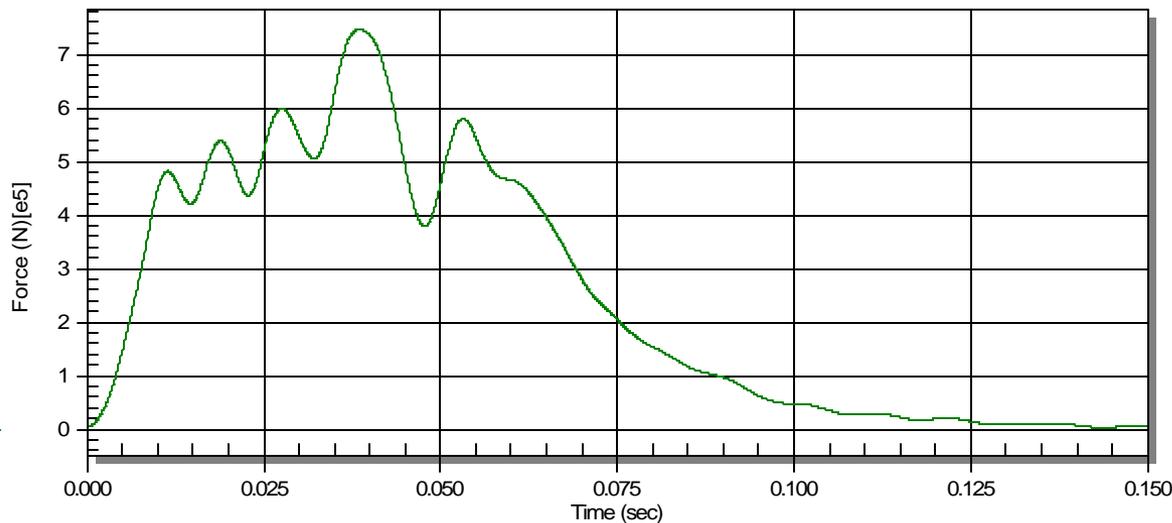
6
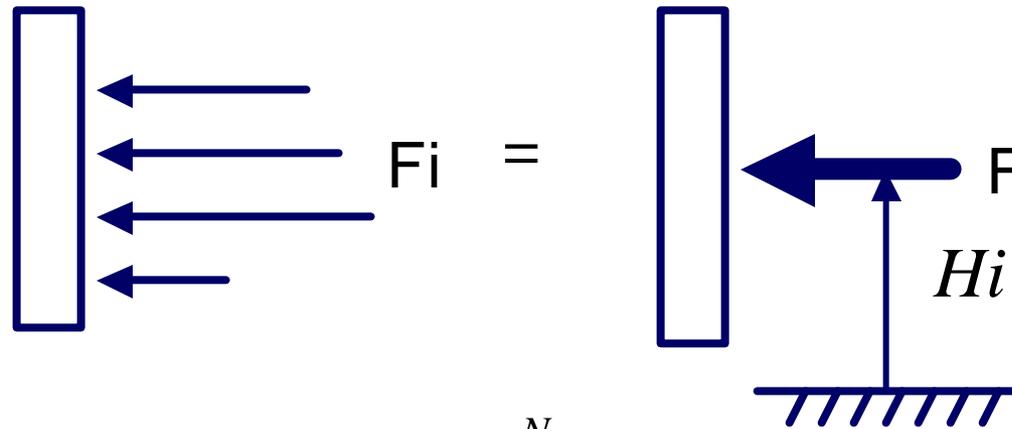
Average Height of Force

Test 2211
1995 FORD EXPLORER

Test 2211
1995 FORD EXPLORER

The height of the center of force varies over the duration of the crash. To compute an average height, the Force-Time curve is used as a "weighting" function to bias the average height towards the height where the higher loads were transferred.

Coefficient of Variation

Standard Deviation / Mean

- for each time interval when total Force > 50 kN
- Average across 4 adjoining load cells
  - ‣ Smooth out or average localized forces
- Ignore outer rows or columns with < 5kN peak force

Intended to measure homogeneity or distribution of stiffness

- Applicable for high resolution barriers

Deformable Barrier Testing

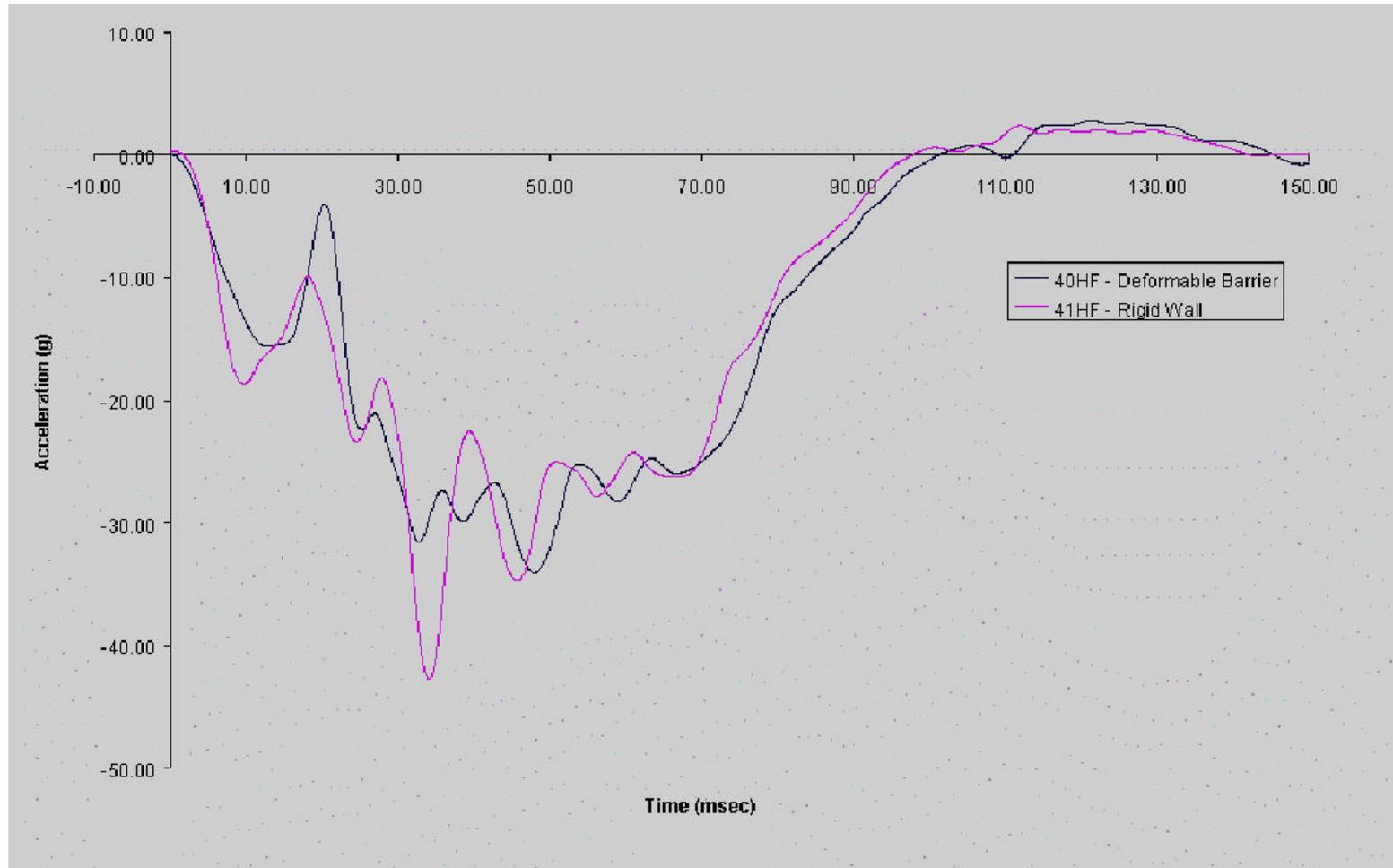Full barrier load cell testing using deformable barrier face

- Removes initial force spikes measured on rigid wall

300 mm of low to moderate psi honeycomb

- Slotted to reduce shear effects
- Minimal effect on measured occupant compartment acceleration
- Does not change AHOF measurements
- Affects coefficient of variation

Full Barrier Deformable Face

Full Deformable Barrier

Offset Barrier Testing

Several variations of offset tests are under investigation for compatibility testing

- Load cells to measure peak loads
- Progressive deformable barrier (PDB)
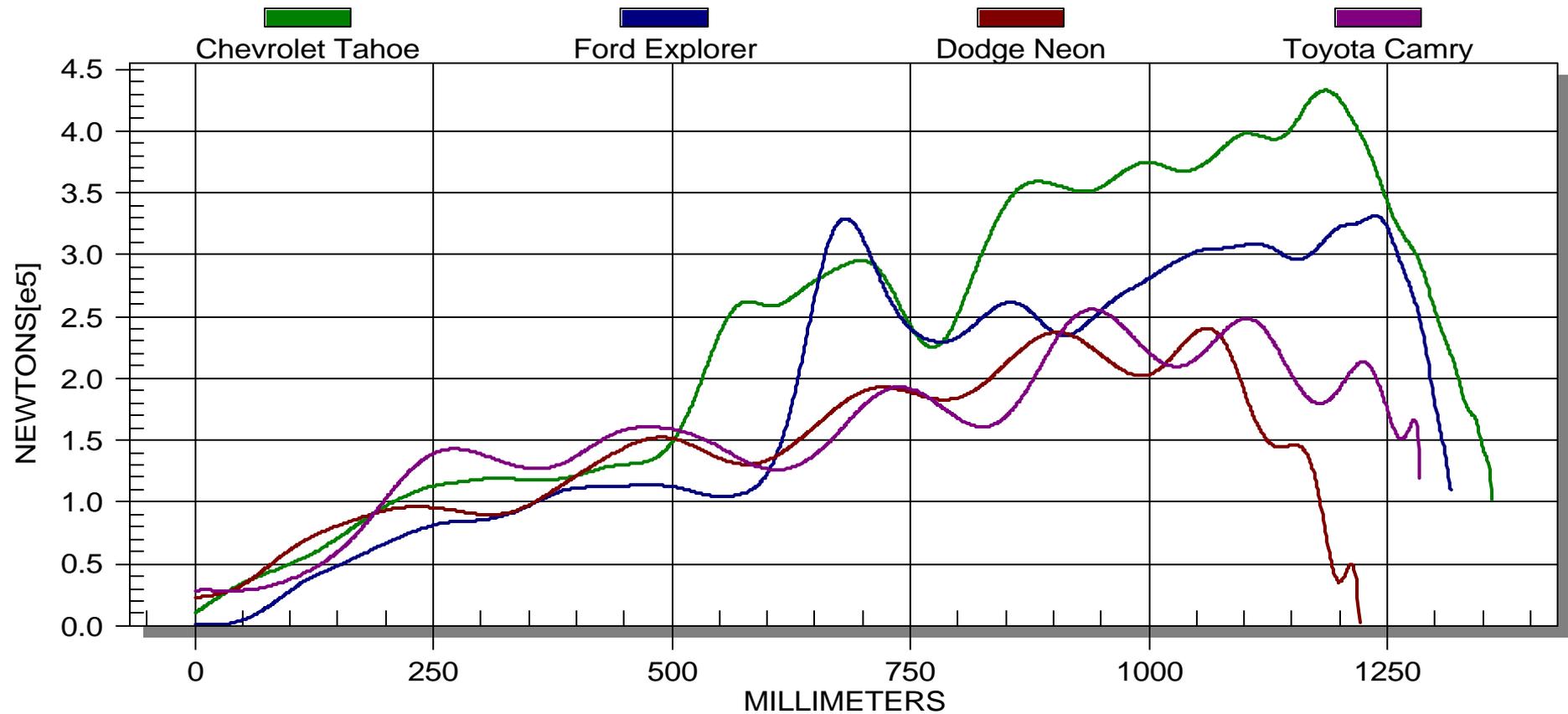- Overload or high speed compartment stiffness test

Offset Load cell barrier

Limit the Peak Force measured on the barrier

- Limited energy absorption for heavy vehicles
- Barrier design needs to accommodate taller LTV's
- Evaluates only X axis force

Offset Loadcell Barrier Forces

Offset Test X axis response

Chevrolet Tahoe   Ford Explorer   Dodge Neon   Toyota Camry
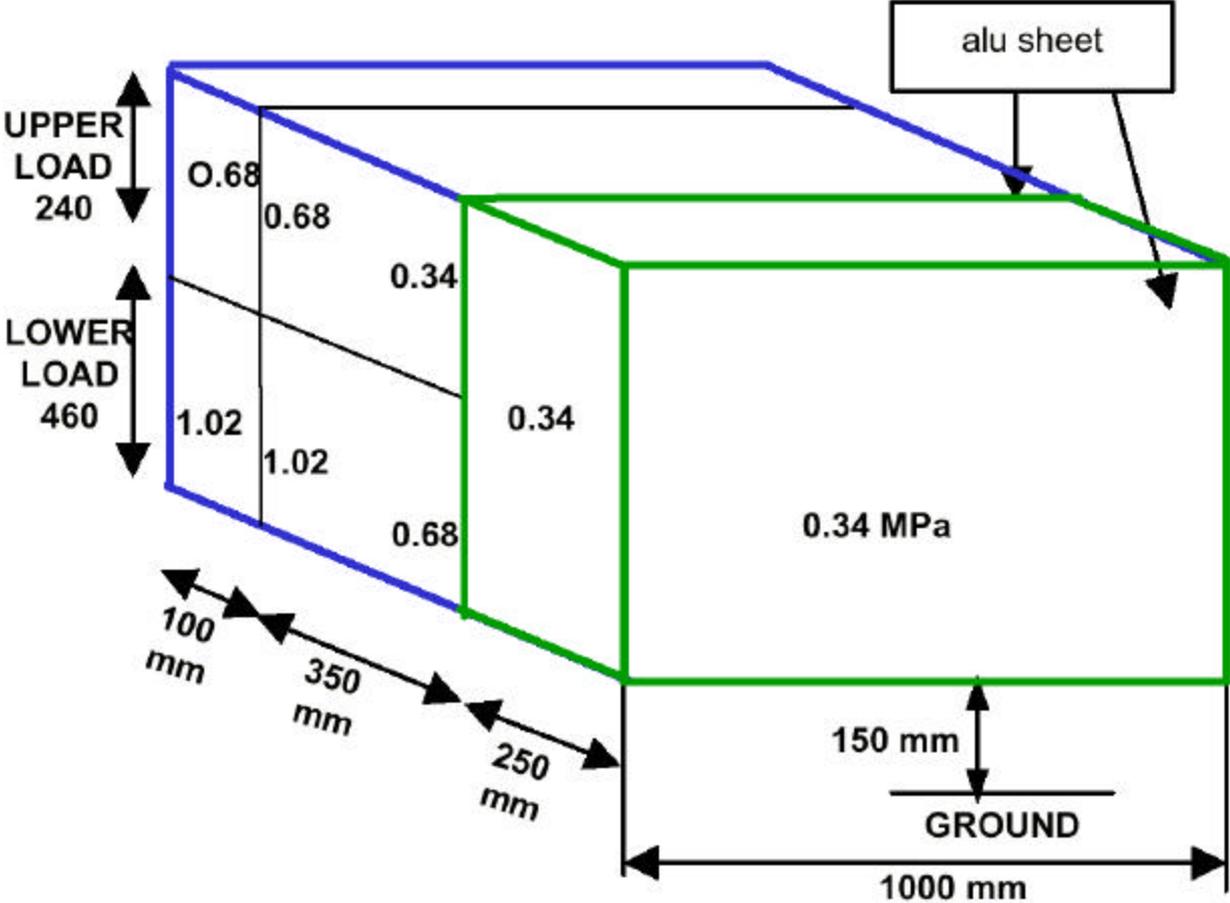
Progressive Deformable Barrier

Limits deformation measured on an offset barrier

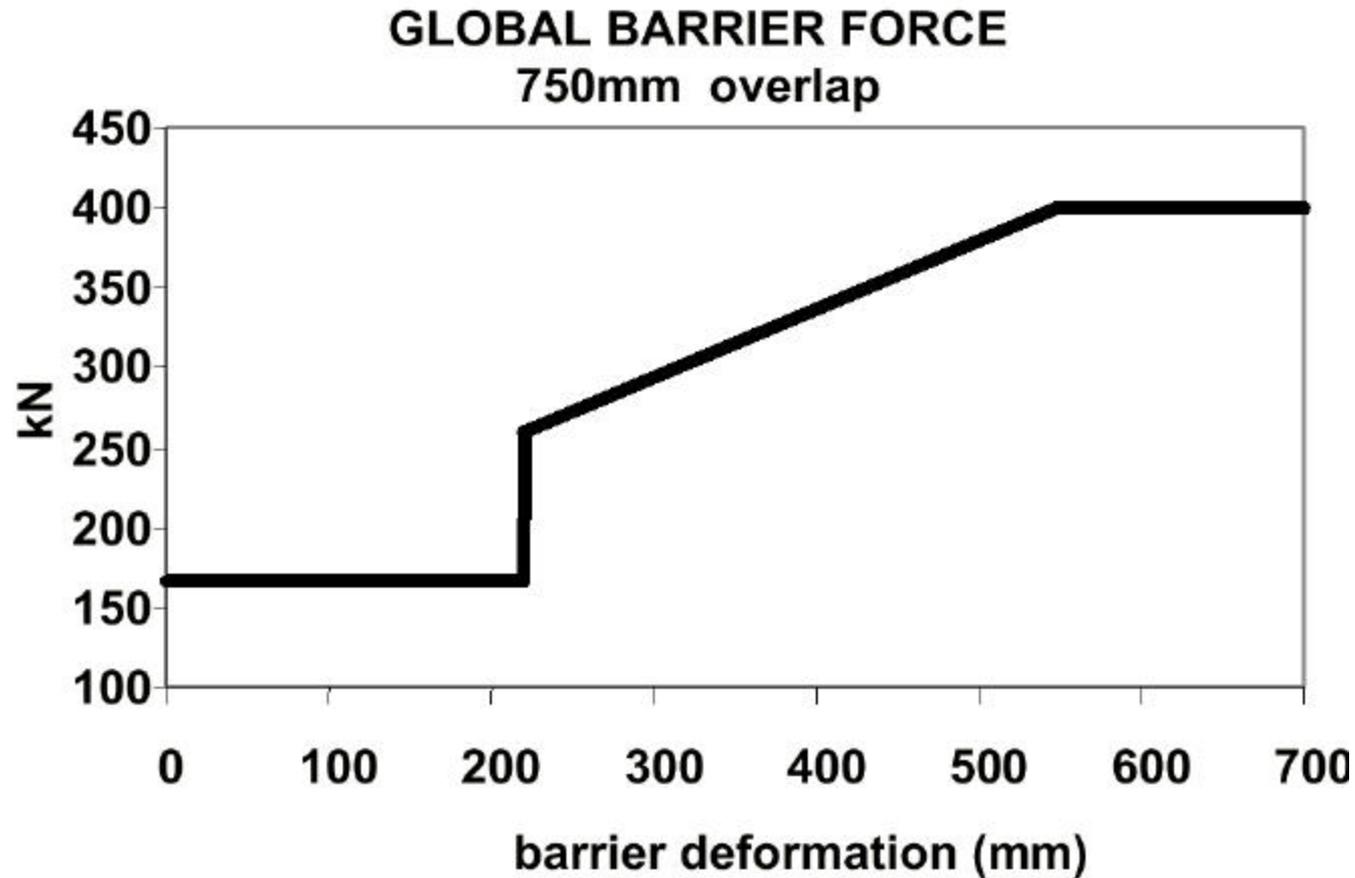Barrier design includes variable stiffness to reflect vehicle design

- Based on the ADAC barrier
- Represents a European small car
- Depth and Height of crush of the barrier face are used to evaluate aggressivity

Progressive Deformable Barrier

Progressive Deformable Barrier

GLOBAL BARRIER FORCE
750mm overlap

x-axis: barrier deformation (mm)
y-axis: kN

PDB Test Methodology

- 60 km/h test into fixed PDB
- Constant overlap of 750 mm
- No instrumented dummies
- Analysis of PDB deformation profile to determine an aggressivity rating
  - Barrier crush depth is divided into 50 mm increments
  - Rating is based on area, avg depth, and avg height within the 50 mm zones

PDB Testing

Overload Test

- High speed offset test
  - Insures that occupant compartment exceeds a minimum crush force that is greater than the crush force for the engine compartment
- No dummies
- Measures occupant compartment crush force
  - Ideally occupant compartment will not crush in typical offset testing
- 80 kmph
- 50 % overlap

Overload Test

Intended to encourage stiffness compatibility between crash partners
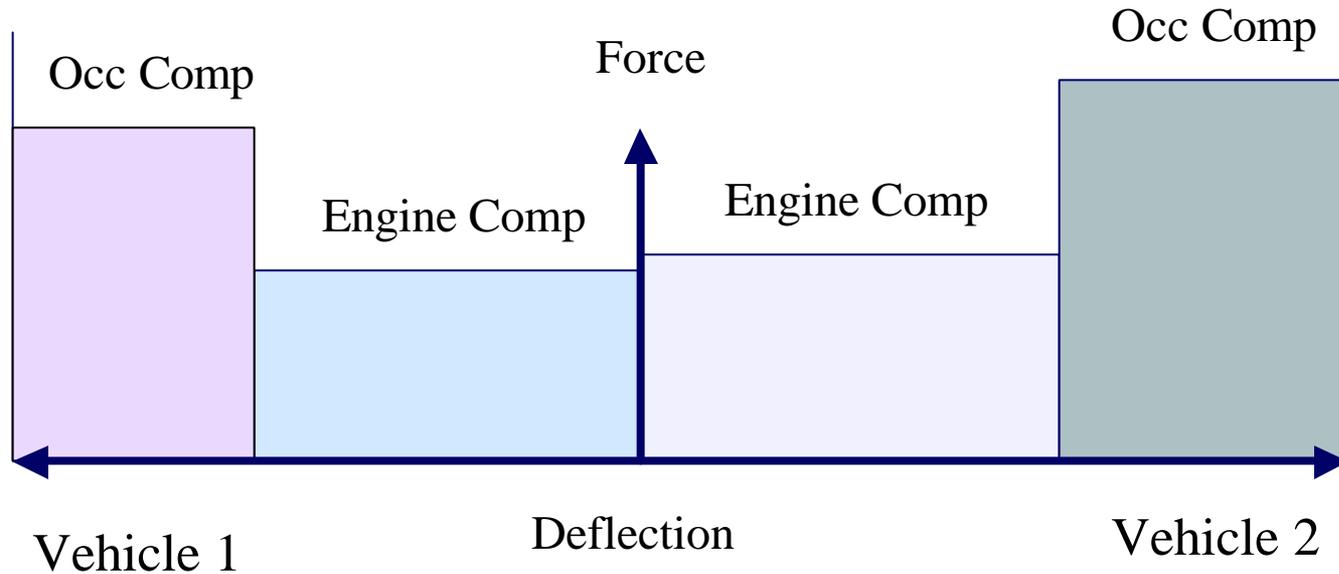
MDB Test Procedures

All of the MDB test procedures are variations on fixed barrier tests

Intended to provide "constant energy" tests

 ⋙ Delta-V of test vehicle depends upon its mass

MDB can be adjusted to match current fleet

 ⋙ Can account for fleet differences in US, Europe, Asia, and Australia

Load cell MDB

Provides similar measures as the rigid load cell wall, but accounts for the mass of the striking vehicle

Measures peak acceleration on partner vehicle

Could also be used to assess self protection of smaller vehicles

Testing includes full frontal and offset test methods

PDB moving barrier

Looks to utilizes the PDB assessment methodology on an MDB

Accommodates a wider range of vehicle masses than the fixed PDB

Research Status

All proposed test methods are under active research by multiple research groups

There is a wide diversity of opinions and preferences for test methods

There is significant ongoing discussion